Sample Proficiency Standard

SCIENCE

A: SCIENCE CONNECTIONS

CONTENT STANDARD

Students in Wisconsin will understand that among the science disciplines, there are unifying themes: systems, order, organization, and interactions; evidence, models, and explanations; constancy, change, and measurement; evolution, equilibrium, and energy; and form and function.

PERFORMANCE STANDARD

A.8.6 Use models* and explanations* to predict* actions and events in the natural world

SCIENCE

C: SCIENCE INQUIRY

CONTENT STANDARD

Students in Wisconsin will investigate problems using scientific methods and tools, revise their personal understandings to accommodate knowledge, and communicate these understandings to others.

PERFORMANCE STANDARD

C.8.3 Design and safely conduct investigations* that provide reliable quantitative or qualitative data, as appropriate, to answer their questions

D. PHYSICAL SCIENCE

CONTENT STANDARD

Students in Wisconsin will demonstrate an understanding of the physical and chemical properties of matter, the forms and properties of energy, and the ways in which matter and energy interact.

PERFORMANCE STANDARD

Transfer of Energy; D.8.9: Explain* the behaviors of various forms of energy* by using models of energy transmission, both in the laboratory and in real-life situations in the outside world.

*Terms with an asterisk are defined in the Glossary of Terms.

SAMPLE TASK

Students were asked to perform the experiment and answer questions about it.

HOT STUFF! is an assessment task in which the students work in small groups in a lab setting to conduct the experiment. The paper and pencil responses to the questions are completed by each individual student and reflect his/her understanding of the experiment.

Purpose

In this inquiry work, you will investigate properties of water and heat transfer and apply the knowledge you have gained from your experiment to real-world problems.

Materials

5 zinc washers with string attached
thermometer
balance
styrofoam cup
hot plate
boiling water
room temperature water

Procedure

1. Carefully find the mass of the zinc washers and string given to you by your teacher. Record the mass in the preliminary data section at the bottom of this page.
2. Place the washers in a boiling water bath.
3. Predict the initial temperature of the washers after sitting for five minutes in the boiling water. Record the prediction in the preliminary data section.
4. Find the mass of a styrofoam cup. Add the mass of tap water that is equal to the mass of the washers and pour it into the Styrofoam cup. Record the mass of the water in the preliminary data section.
5. Measure the temperature of the water in the styrofoam cup and record it in the preliminary data section.
6. Measure the temperature of the water in the hot water bath. Record the temperature of the water bath in the preliminary data section.

Preliminary Data Section

_____ washer mass (g)

_____ water mass (g)

_____ water temp. of hot water bath

_____ predicted temp. of both water and washers

_____ predicted water temp. °C

_____ initial water temp. °C

Follow all your teacher's safety guidelines for this lab!

SAMPLES OF STUDENT WORK

EXPLANATIONS OF RATINGS OF STUDENT WORK

The following criteria were used to evaluate the student work. They were shared with the students before they attempted the task. They were designed to help the student understand the knowledge, skills, concepts, and presentation that was used for the assessment.

The criteria included: *knowledge* (understanding of heat transfer, transfer of knowledge to real-world situations, and use of analogies); *inquiry or use of science skills* (mechanical completeness, accuracy of mathematics and data, presentation of data, use of science terms, and predictions); and *presentation* (material that is understandable to others, use of vocabulary, and use of language such as spelling, etc.).

Advanced

This student clearly has an advanced understanding of this investigation and shows this by using prior knowledge. The chart is well organized. The vocabulary use is exceptional. There are several arguments for the real-world presentations, based on the student's own data. The paper is well written and is clearly understood by the reader. The student accounts for the prediction being different than the experimental results.

7. Suppose the washers are taken out of the boiling water and placed into the water in the Styrofoam cup. They are then allowed to sit until both the washers and the water reach the same temperature. Predict what this final temperature of both the water and th washers will be. Record your prediction in the **preliminary data section** on the previous page.

Explain your reasons for predicting this temperature.

The washers will give off as much heat as it can until the water temperature equals the washer temperature. I predict that it will reach this equilibrium at 45°C. The washers would give off about half of its total amount and the water will not completely double its temperature. It will come a few degrees short of doubling its temperature.

8. With safety in mind, carefully transfer the steel washers from the hot water into the Styrofoam cup of water.

9. Take the temperature of the water in the Styrofoam cup every 15 seconds. Record the temperatures in the **data section**. Continue the temperature recording until the temperature reaches a maximum.

Data Section

Time (sec)	Temp (°C)
0	24°
15	27
30	29
45	29
60	31
75	31
90	31
105	31
120	31

Calculate the temperature change of the water and the temperature change of the metal.

CALCULATIONS

Metal: 85 - 31 = a decrease of 54°

Water: 24 → 31 = an increase of 7°

Explain the differences in the two temperature changes you just calculated.

I can think of two reasons for the differences in the two temperatures. The first considers the conductivity of each part. Metal is a better conductor of heat energy than water. Therefore, the metal washers transfer the heat faster than the water. This explains the larger change of temperature in the metal than in the water. The second reason deals with the volume of the water. If the volume of the water is larger than the volume of the metal then the result will be a smaller change in temperature in the water.

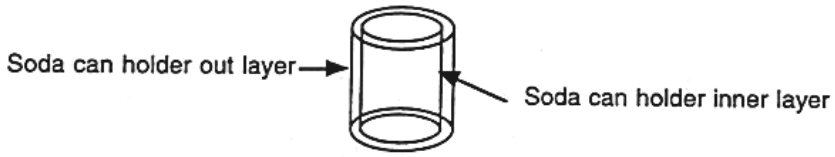
The city of Milwaukee is located on the Lake Michigan shore, while Madison is located 80 miles inland. On a sunny day in July the 2 p.m. temperature in Milwaukee was 82°F; in Madison the temperature was 95°F.

How can this be explained in terms of your experimental results?

The sun is compareable to the metal in the experiment. The sun is giving off its heat energy. Water temperature is lower than the air temperature. In Milwaukee the sun's energy is being absorbed by the water. In Madison the energy is being used to heat the land. Because the initial temp. of the water is less than the temp of the air around Madison its final temp. is less. Just as if in our experiment the initial temp. of the water in the styrofoam cup was lower than the final temperature after the metal was placed would be lower.

A student is designing the perfect soda can holder, which will keep the soda cold. The holder is made of two plastic layers with a space in-between. Refer to the diagram below.

Should the student fill the space with solid steel or an <u>equal mass</u> of water?



Explain in terms of your experimental results.

The student should fill the space with an equal mass of water. Metal is a better conductor of heat than water so the heat from the sun will warm the water. As the heat is transferred the temperature of the can will drop. The

same as the metal washers and the result was a drop in the temperature of the washers. The water will also continue to keep the can cold. In the experiment the metal decreased alot and the water increased some but then they remained at that equilibrium. The water and the can would also remain at an equilibrium point. Filling the space with an equal mass of water is the best choice. Water is not as good of a conductor as metal. The water will not transfer the cold from the can. Steel would because it is a better conductor of thermal energy.

Proficient

The paper is complete and accurate. It shows a clear understanding of the experiment. There is good use of scientific terminology and a clear indication of an understanding of heat transfer. The student applies the results of the experiment to the real-world problems successfully.

7. Suppose the washers are taken out of the boiling water and placed into the water in the Styrofoam cup. They are then allowed to sit until both the washers and the water reach the same temperature. Predict what this final temperature of both the water and the washers will be. Record your prediction in the **preliminary data section** on the previous page.

Explain your reasons for predicting this temperature.

The reasons for predicting the temperature at about 75 degrees is because I chose a number that was a little warmer that the number in between the room temperature water and my hypothesis on the temperature of the heated washers. I think the warmer object will have a bigger impact on the final temp of both the washers & water together.

8. With safety in mind, carefully transfer the steel washers from the hot water into the Styrofoam cup of water.

9. Take the temperature of the water in the Styrofoam cup every 15 seconds. Record the temperatures in the **data section**. Continue the temperature recording until the temperature reaches a maximum.

Data Section

Time	Temp
Beginning Temp	24°
0	28°
15	29°
30	30°
45	31°
60	31°
75	31°

Calculate the temperature change of the water and the temperature change of the metal.

CALCULATIONS	
Temperature Change in the H_2O 31°C −24°C 7° ☆ It had a 7°C temp change.	Change (in temp) in the H_2O 42°C − predicted − 31°C 11°C ☆ It had a 11°C temp change.

Explain the differences in the two temperature changes you just calculated.

The differances between the temperatures above is the differance in the water temperature that actually happened. The change on the right side was a prediction or hypothesis. The left colomn is actual + the right column is predicted so everyone's will be differant on the right side + mostly the same on the left. The hot metal causes the room temp. water to go up 30°. The cooler water also helps the metal to cool down to about 30°.

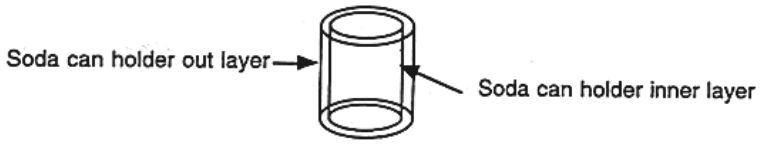
The city of Milwaukee is located on the Lake Michigan shore, while Madison is located 80 miles inland. On a sunny day in July the 2 p.m. temperature in Milwaukee was 82°F; in Madison the temperature was 95°F.

How can this be explained in terms of your experimental results?

Because Milwaukee is closer to the lake shore, the water makes the summers a little bit cooler that the city that is more inland. The city that is inland has no other way to cool down in the summer. Like our experiment explains, the hot metal would be the 2 cities, and the water is the lake. The metal cools down when it is near the cooler water. If the metal were not in water, it would take much longer to cool down.

A student is designing the perfect soda can holder, which will keep the soda cold. The holder is made of two plastic layers with a space in-between. Refer to the diagram below.

Should the student fill the space with solid steel or an <u>equal mass</u> of water?



Explain in terms of your experimental results.

Water → It changes temp more slowly than metal. If you use water, it will keep the soda colder for a longer amount of time than the metal would.

Basic

The student has partially used the science terminology correctly. He or she has presented the investigation in a manner that indicates partial understanding of the concepts of heat transfer. The paper shows limited transfer of the results from the experiment to the real-world problems.

7. Suppose the washers are taken out of the boiling water and placed into the water in the Styrofoam cup. They are then allowed to sit until both the washers and the water reach the same temperature. Predict what this final temperature of both the water and the washers will be. Record your prediction in the **preliminary data section** on the previous page.

Explain your reasons for predicting this temperature.

The washers will give off as much heat as it can until both have an equal temperature. I don't think that the temps will be that high from the initial temps. of the water. Finally, I think the temps will go up.

8. With safety in mind, carefully transfer the steel washers from the hot water into the Styrofoam cup of water.

9. Take the temperature of the water in the Styrofoam cup every 15 seconds. Record the temperatures in the **data section**. Continue the temperature recording until the temperature reaches a maximum.

Data Section

time (sec)	Temp.
0	24
.5	27
3.0	29
4.5	29
6.0	31
7.5	31
9.0	31
1.05	31
1.20	31

Calculate the temperature change of the water and the temperature change of the metal.

CALCULATIONS

Metal 95 - 31 : 64°C

Water - 31 - 24 = 7°C change

Explain the differences in the two temperature changes you just calculated.

The temperature of the metal was off the furthest because the temp of the water was high and the temp of the water didn't go up real high. The temp of the water was close because the heat from the metal add a little bit of heat to the water.

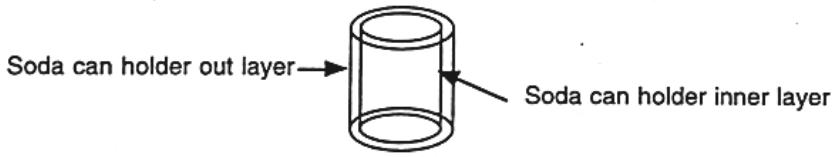
The city of Milwaukee is located on the Lake Michigan shore, while Madison is located 80 miles inland. On a sunny day in July the 2 p.m. temperature in Milwaukee was 82°F; in Madison the temperature was 95°F.

How can this be explained in terms of your experimental results?

Whenever you move towards a lake the temperature is more cooler. This is because the temperature of the water in the lake makes the temp close by the lake cooler. The farther you are away its going to be warmer because you are not close to the lake.

A student is designing the perfect soda can holder, which will keep the soda cold. The holder is made of two plastic layers with a space in-between. Refer to the diagram below.

Should the student fill the space with solid steel or an <u>equal mass</u> of water?



Explain in terms of your experimental results.

The student should fill the space with solid steel. I think if the student does it will keep the coldness in the holder better the solid steel would be a better insulator for the water. This is why I think that the student should fill the empty space with steel.

Minimal

The paper indicates that the student attempted the investigation. The work presented is only partially accurate. The calculations are difficult to follow and the work was set up incorrectly, but there were answers. The answers were short and incomplete

7. Suppose the washers are taken out of the boiling water and placed into the water in the Styrofoam cup. They are then allowed to sit until both the washers and the water reach the same temperature. Predict what this final temperature of both the water and the washers will be. Record your prediction in the **preliminary data section** on the previous page.

Explain your reasons for predicting this temperature.

My idea is the Temprature will reache a happy.

8. With safety in mind, carefully transfer the steel washers from the hot water into the Styrofoam cup of water.

9. Take the temperature of the water in the Styrofoam cup every 15 seconds. Record the temperatures in the **data section**. Continue the temperature recording until the temperature reaches a maximum.

Data Section

time in 15sec. intervals	temp.
1	28
2	28
3	28
4	28
5	28
6	28.5
7	29
8	29
9	29
10	29
11	30
12	30
13	30
14	30
15	30

Calculate the temperature change of the water and the temperature change of the metal.

CALCULATIONS

23.5 to 30 = 6.5 Charge

Assumed Washers = 100° C - 30°C = 70°C Final
final temp
temp change

Explain the differences in the two temperature changes you just calculated.

The differences in the temperature are larger then each other. So we make the assumetion that water com absorb more heat than metal

The city of Milwaukee is located on the Lake Michigan shore, while Madison is located 80 miles inland. On a sunny day in July the 2 p.m. temperature in Milwaukee was 82°F; in Madison the temperature was 95°F.

How can this be explained in terms of your experimental results?

Water absorbs more heat than does the other objects

A student is designing the perfect soda can holder, which will keep the soda cold. The holder is made of two plastic layers with a space in-between. Refer to the diagram below.

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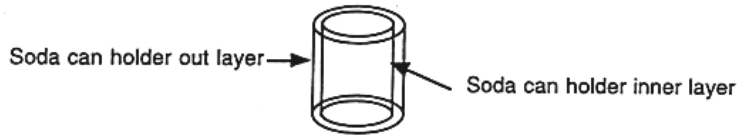

Explain in terms of your experimental results.

Steele - it wont obsorb as much heat as the water would